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Detection in graphene and other 2D materials: towards a tunable THz camera

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1. Extended Abstract

The large number of applications of THz rays to security screening, biomedical imaging and industrial process diagnostics motivates the efforts still spent for realizing high performance, low cost, large-scale THz detectors operating at room temperature with fast response time. Over the past 10 years, the good detection properties of field effect transistors (FET) have been extensively demonstrated when using silicon, gallium arsenide, gallium nitride bulk as well as III-V semiconductors nanowires [1]. The basic mechanism of these detectors exploits the nonlinear properties of the 2D plasma, which can be excited into the FET channel by simultaneously biasing the gate and source contacts by means of the ac voltage carried by the THz rays.

Recently, a novel class of potentially very fast (> GHz) FET devices employing graphene field effect transistors (GFETs) have been reported to efficiently detect THz light at room temperature [2-4]. The combination of the atomic-scale thickness, the large length scalability of the channel and the potentially extremely high carrier mobility reachable in graphene sheets make GFETs ideal candidates for excellent detection performances. At the same time, the rapidly progressing development of wafer scale growth and transfer techniques ensures the possibility of easily integrating GFETs into conventional Silicon CMOS technology, paving the way to the realization of THz large area focal plane arrays with high responsivity and ultrafast response time. In this direction, a new approach relying on seeded growth has been shown to be capable of producing large monocrystalline graphene flakes in a chosen ordered pattern [5], and appears then particularly suited for the implementation of a low-cost THz camera detector.

In parallel, detectors based on other 2D layered materials are being demonstrated, relying for instance on black phosphorous [6]. Owing to their gapped semiconductor nature they offer the promise of higher FET transconductance and, as consequence, higher responsivities. Furthermore, thanks to their anisotropy, they provide the opportunity of operating by design either as non-linear or thermoelectric detectors, constituting an ideal platform to study the actual physics of the detection mechanism.

In this talk I will discuss the latest achievements in this fascinating area of THz research, focusing in particular on the remaining challenges for a full technological development and exploitation of these devices.

2. References

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